(2)

MTL TR 90-16

AD-A221 124

PRECIPITATION ON DISLOCATIONS IN Al-Li-Cu-Mg-Zr

D. M. VANDERWALKER
MATERIALS SCIENCE BRANCH

March 1990

US ARMY
LABORATORY COMMAND
MATERIALS TECHNOLOGY LABORATORY

U.S. ARMY MATERIALS TECHNOLOGY LABORATORY
Watertown, Massachusetts 02172-0001

REPORT DOCUMENTATION PAGE		READ INSTRUCTIONS BEFORE COMPLETING FORM
1. REPORT NUMBER MTL TR 90-16	2. GOVT ACCESSION NO.	3. RECIPIENT'S CATALOG NUMBER
4. TITLE (and Subtitle) PRECIPITATION ON DISLOCATIONS IN Al-Li-Cu-Mg-Zr		5. TYPE OF REPORT & PERIOD COVERED Final Report 6. PERFORMING ORG. REPORT NUMBER
7. AUTHOR(s) D. M. Vanderwalker		8. CONTRACT OR GRANT NUMBER(s)
9. PERFORMING ORGANIZATION NAME AND ADDRESS U.S. Army Materials Technology Laboratory Watertown, Massachusetts 02172-0001 SLCMT-EMS		10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS D/A Project: 1L161102.AH42
11. CONTROLLING OFFICE NAME AND ADDRESS U.S. Army Laboratory Command 2800 Powder Mill Road Adelphi, Maryland 20783-1145		12. REPORT DATE March 1990 13. NUMBER OF PAGES 8
14. MONITORING AGENCY NAME & ADDRESS (if different from Controlling Office)		15. SECURITY CLASS. (of this report) Unclassified 15a. DECLASSIFICATION/DOWNGRADING SCHEDULE

16. DISTRIBUTION STATEMENT (of this Report)

Approved for public release; distribution unlimited.

17. DISTRIBUTION STATEMENT (of the abstract entered in Block 20, if different from Report)

18. SUPPLEMENTARY NOTES

19. KEY WORDS (Continue on reverse side if necessary and identify by block number)

Aluminum alloys,
~~Al-Li-Cu-Mg-Zr~~
Transmission electron microscopy, ~~(TEM)~~
Dislocations,
Precipitation, JES

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

(SEE REVERSE SIDE)

Block No. 20

ABSTRACT

Transmission electron microscopy was used to study precipitation processes on dislocation lines in Al-2.5Li-1.3Cu-0.7Mg-0.12Zr wt% aged at 190°C. Upon aging, a series of dislocation dissociation and precipitation reactions occur. The T_1-Al_2CuLi phase nucleates on dislocations in the (111) glide planes inducing the lattice dislocation to dissociate. On the remaining dislocation segment, $S'Al_2CuMg$ plates form causing the lattice dislocation to dissociate into a configuration with a Shockley partial on one side and a climbing partial on the other, such that S' plates are on the (210) plane. T_1 phases nucleate from the surface of S plates on conjugate {111} with an interfacial dislocation glide motion.

Accession For	
NTIS CRA&I	☒
DTIC TAB	☐
Unannounced	☐
Justification	
By	
Distribution/	
Availability Codes	
Dist	Avail and/or Special
A-1	

INTRODUCTION

Research on the structure and properties of aluminum lithium alloys is important for development in aerospace applications.[1,2] The desirable features are the low density, high strength to weight ratio. The phase equilibria of various Al-Li alloys,[3] binary, ternary, and quaternary systems, was examined by Mondolfo.[4] The lattice parameter of aluminum was found to decrease with increasing lithium concentration. In the binary system, there is fcc-AlLi of lattice parameter a = 0.638nm, $AlLi_2$, and cubic δ'-Al_3Li of lattice parameter a = 0.401nm. Al_3Li is thought to form as part of a precipitation sequence from supersaturated solid solution SSSS → Al_3Li → AlLi.[5] In the Al-Li-Cu ternary, the compounds which form are tetragonal θ-$CuAl_2$ of lattice parameters a = 0.6063nm, c = 0.4872nm, hexagonal T_1-Al_2Cu Li of lattice parameters a = 0.497nm, c = 0.934nm, T_2-Al_5Li_3Cu bcc of lattice parameter a = 1.3914nm, and T_B $Al_{7.5}Li$ Cu_4 fcc of lattice parameter a = 0.583nm, as well as transition phases. The quaternary Al-Cu-Li-Mg was reported to have the orthorhombic S'Al_2CuMg with lattice parameters a = 0.400nm, b = 0.925nm, and T_1-Al_2CuLi.

The mechanical properties of Al Li alloys depend on the structure. The strength of Al-Li increases with lithium concentration.[5-8] The effect is thought to be order hardening and modulus hardening associated with Al_3Li precipitation.[6] The increase in modulus can be attributed to both Li in solution and Al_3Li. The addition of Mg causes the modulus to drop slightly. The fracture toughness was found to improve with S-Al_2CuMg precipitation.[8] T_1-Al_2CuLi contributes to the increase in strength.[9] The addition of Mg improves the strength by replacing some T with S.[10] The grain size is refined by the addition of Zr.[8]

The nucleation and growth of second phases in AlLi alloys has been investigated. Al_3Li forms homogeneously in the matrix as a dense array of spherical particles. The growth is diffusion controlled Ostwald ripening following $t^{1/3}$ kinetics. Attempts have been made to measure the interfacial energy from coarsening relations.[11] δ'-Al_3Li has been found to nucleate at Al_3Zr precipitates forming an outer core shell around the spherical Al_3Zr particle.[11] Al_3Li precipitate free zones form at grain boundaries.[3] This report is on precipitation processes on dislocations in Al-Li-Cu-Mg-Zr.

EXPERIMENTAL PROCEDURE

A bar of Al-2.5Li-1.3Cu-0.7Mg-0.12Zr wt% 8090 alloy was spark cut into thin slices. The foils were polished, encapsulated in vacuum tubes, and solution annealed for 15 minutes at a temperature of 530°C. Samples were wrapped in Al foil and aged at 190°C for various lengths of time in an atmospheric tube furnace. The flowing gas was either nitrogen or

1. Aluminum Lithium II. T. H. Sanders, Jr. and E. A. Starke, Jr., ed., TMS-AIME, Warrendale, PA, 1983.
2. Aluminum Lithium III. C. Baker, P. J. Gregson, S. J. Harris, C. J. Peel, ed., The Institute of Metals, London, England, 1986.
3. KELLY, A., and NICHOLSON, R. B. *Precipitation Hardening*. Prog. Mat. Sci., v. 10, 1963, p. 151.
4. MONDOLFO, L. F. *Aluminum Alloys: Structure and Properties*. Butterworths, London, England, 1976.
5. NOBLE, B., and THOMPSON, G. E. *Precipitation Characteristics of Aluminum - Lithium Alloys*. Met. Sci. J., v. 5, 1971, p. 114.
6. NOBLE, B., HARRIS, S. J., and DINSDALE, K. *Yield Characteristics of Aluminum Lithium Alloys*. Met. Sci. J., v. 16, 1982, p. 425.
7. NOBLE, B., HARRIS, S. J., and DINSDALE, K. *The Elastic Modulus of Aluminum Lithium Alloys*. J. Mat. Sci., v. 17, 1982, p. 461.
8. GREGSON, P. J., and FLOWER, H. M. *Microstructural Control of Toughness in Aluminum - Lithium Alloys*. Acta. Metall., v. 33, 1985, p. 527.
9. CASSADA, W. A., SHIFLET, G. J., and STARRE, E. A., Jr. *The Effect of Plastic Deformations on T1 Precipitations*. J. de Phys. Colloq., v. 48, 1987, p. C3-397.
10. HARRIS, S. J., NOBLE, B., and DINSDALE, K. *The Role of Magnesium in Al-Li-Cu-Mg-Zr Alloys*. J. de Phys. Colloq., v. 48, 1987 p. C3-415.
11. GREGSON, P. J., and FLOWER, H. M. *S' Precipitation in Al-Li-Mg-Cu-Zr Alloys*. J. Mat. Sci. Letters, v. 3, 1984, p. 829.

argon. Three millimeter discs were electropolished in a 1/3 nitric acid, 2/3 methanol solution. The transmission electron microscopy was performed on the JEM 200 CX electron microscope.

RESULTS

The precipitation in Al-Li-Cu-Mg-Zr was examined by transmission electron microscopy. Annealed samples were found to contain coherent $CuAl_2$ precipitates. Helical dislocations form on quenching as a result of dislocation climb. On aging at a temperature of 190°C three phases nucleate: δ'-Al_3Li, S'-Al_3CuMg, and T_1-Al_2CuLi.

All four phases are visible in the bright field image from a sample aged for 16 hours at 190°C (see Figure 1). Double lobe strain contrast is present from round θ-$CuAl_2$ precipitates in the matrix. A layer of $\delta'Al_3Li$ forms around the particles, as well as in the matrix, as small round coherent phases. The S'-Al_2CuMg nucleates on dislocations as parallel plates and in the matrix as large rods at three orientations. Composite sheets of S' plates were also observed.[12]

Figure 1. Four phases in Al-Li-Cu-Mg-Zr aged for 16 hours at 190°C.
θ-$CuAl_2$, $\delta'Al_3Li$, T_1Al_2CuLi, and $S'Al_2CuMg$.

The T_1-Al_2CuLi phase nucleates on dislocations and at heterogeneous sites in the matrix. There are displacement fringes on the surface of large T_1 plates at one orientation in Figure 1 and dark lines of the projected thickness at the other. The S' and T_1 phases can be distinguished by orientation since the S' is in the {210} plane and the T_1 in the {111}. Both S'-Al_2CuMg and T_1-Al_2CuLi nucleate on dislocations after aging for eight hours at 190°C (see

12. WILSON, R. N., and PARTRIDGE, P. G. *The Nucleation and Growth of S' Precipitates in an Aluminum - 2.5% Copper - 1.2% Magnesium Alloy.* Acta. Metall., v. 13, 1965, p. 1321.

Figure 2). The T_1 phases are both in the glide plane of the dislocation line and on conjugate {111} planes. The lattice dislocations are induced to dissociate in the glide plane by the T_1 plate. The partials are the interfacial dislocations of T_1. There is an interruption in the dislocation line when the T_1 phases are located. The nucleation of the S'-Al_2CuMg phase *on* the dislocation causes the dissociation of the remainder of the dislocation line ξ = [101] into a Shockley partial on one side and an indeterminate dislocation obscured by the S' precipitate plates on the other side (see Figure 3). Shockley partial dislocation loops nucleate on the surface of the plates and interfacial dislocations form a square net on the surface (see Figure 3) where plates coincide. The T_1 phase on the conjugate planes grows from segments on the (210) plane of the S' plates. θ-$CuAl_2$ is visible in the matrix.

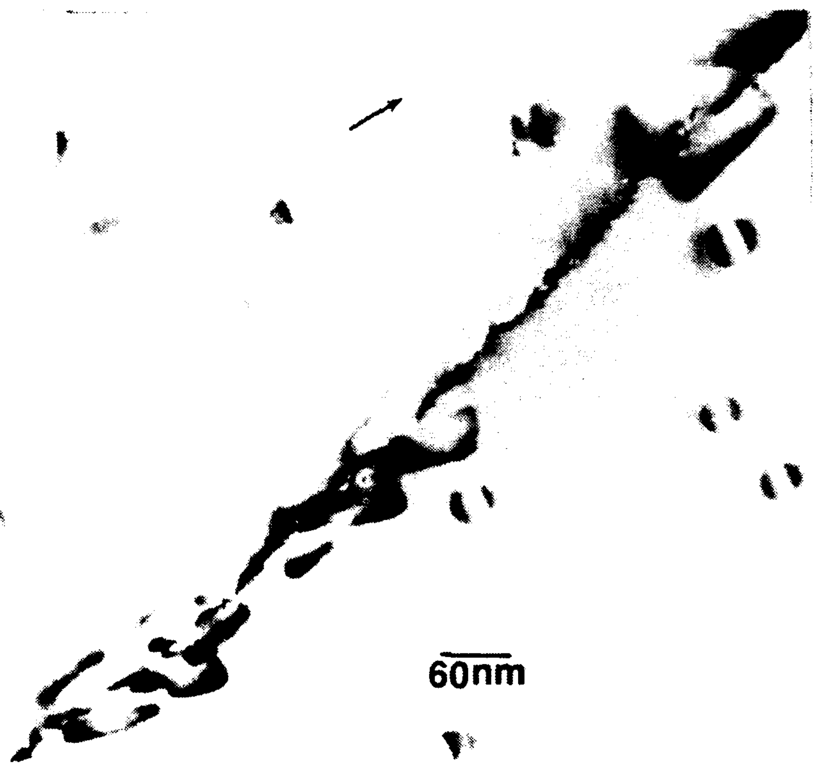

Figure 2. T_1-Al_2 and S'-Al_2CuMg nucleate on dislocations in a sample aged for eight hours at 190°C. There are interruptions in S' precipitation where large T_1 plates are located.

The large sheets of S' plates begin growth by the nucleation of rods on dislocations. Figure 4 is a dark-field image of S' nucleation on a helical dislocation at periodic positions where the dislocation segment is parallel to the <100> growth axis. Closely spaced rods nucleate on the dislocation segments in between each long rod, as at the helix on the left of Figure 5. There is a well developed S' sheet on the right side of Figure 5 with plates oriented along [010] direction. Nucleation on a helical dislocation results in a wavy sheet of S' plates. $\delta'Al_3Li$ precipitates on $CuAl_2$ and coarsens to form a spherical layer. Distorted spheres of Al_3Li are also observed on dislocation lines.

Figure 3. The precipitation of S'-Al_2CuMg and the dissociation of the lattice dislocation into a configuration with a Shockley partial on one side. Interfacial dislocation nets and Shockley partial loops are visible on the surface. The sample was aged for nine hours at 190°C.

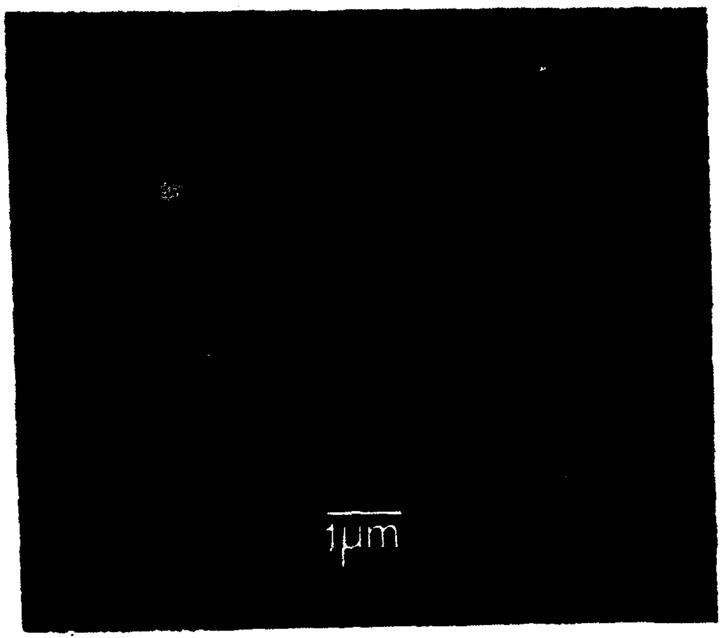

Figure 4. Dark field image of S'-Al_2CuMg rods on a dislocation helix. The specimen was aged for eight hours at 190°C.

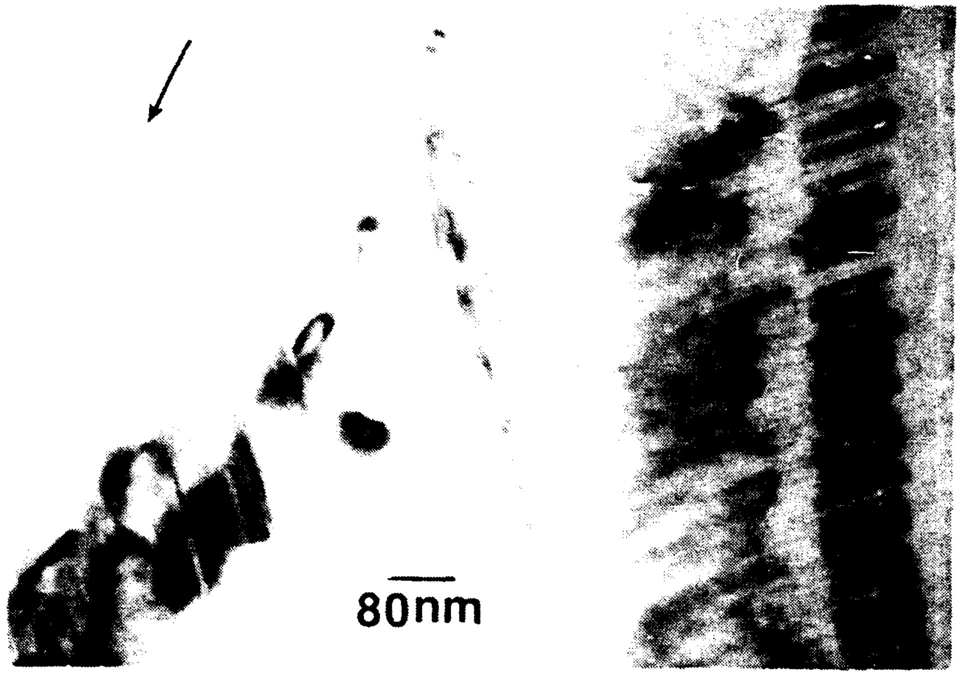

Figure 5. A wavy S'-Al_2CuMg sheet formed by precipitation on dislocation helix. The sample was aged for nine hours at 190°C.

DISCUSSION

A set of dislocation dissociation and precipitation reactions occur on dislocation lines in the Al-Li-Cu-Mg-Zr system. At shorter aging at a temperature of 190°C, the precipitation is heterogeneous. Upon annealing and quenching, dislocation climb by the absorption of vacancies produces dislocation helix configurations.[13] This climb process involves the incorporation of vacancy loops which nucleate next to the line. The shape of the dislocation line[14] depends on character, vacancy supersaturation, and solute concentration. In aluminum, the dislocations are undissociated of Burgers vector a/2 [110]. The Burgers vector is parallel to the axis of the helix in the case where the initial dislocation is of screw character.[15] The vacancy absorption by dislocations has been found to take place in Al alloys and not in pure Al.

The vacancy supersaturation is higher in alloys due to the effective reduction in vacancy formation energy associated with solute-vacancy binding.[3] In this Al-Li system, both the vacancy-Mg[16] and vacancy-Li[17] binding energies are significant. There is likely to be solute segregation on annealing and aging with the migration of vacancies and solute to dislocation lines. The enhanced vacancy concentration increases the atomic diffusivity and reaction rate.

13. HIRTH, J. P., and LOTHE, J. Theory of Dislocations. John Wiley & Sons, New York, NY, 1982.
14. BALLUFFI, R. W., and GRANATO, A. V. Dislocations in Solids. F. R. N. Nabarro, ed., North Holland, Amsterdam, 1979.
15. NOBLE, B., and THOMPSON, G. *T_1 (Al_2CuLi) Precipitation in Aluminum-Copper-Lithium Alloys.* Metal Sci. J., v. 6, 1972, p. 167.
16. FEDERIGHI, F., and THOMAS, G. *The Interaction Between Vacancies and Zones and the Kinetics of Pre-precipitation in Al-Rich Alloys.* Phil. Mag., v. 7, 1962, p. 127.
17. CERESARA, S., GIRANA, A., and SANCHEZ, A. *Annealing of Vacancies and Aging in Al-Li Alloys.* Phil. Mag., v. 35, 1977, p. 97.

In the formation of a helix, the line tension forces of the dislocation balance the osmotic forces for an equilibrium configuration.[13] The precipitation of S'-Al_2MgCu introduces pinning points along the line equal to the pitch of the helix which increase the line tension (see Figure 4). The disturbance of the equilibrium situation by the change in line tension may cause the dislocation to climb in the reverse direction emitting vacancies. The excess vacancies near the dislocation can stimulate precipitate growth near segregated regions.

The dislocation lines are severely altered by precipitation processes involving glide and climb. The first precipitation reaction on the lattice dislocation is the nucleation of T_1 - Al_2CuLi on the (111) plane inducing the glide reaction. T_1 has been thought to nucleate by a stacking fault mechanism.[9,13] The Suzuki effect may contribute to the dissociation reaction in Al-Li-Cu-Mg-Zr by which the stacking fault energy decreases with segregation. The decrease in stacking fault energy in Al 16% Ag with respect to pure Al was attributed to the Suzuki effect.[18] Next, along undissociated segments S^1-Al_2MgCu nucleates and grows on the (210) plane at a 39° inclination to the glide plane. Contrast experiments show that there is a Shockley partial remaining on one side. Since the other dislocation moves out of the glide plane by a climb motion, it must be a Frank partial by the reactions $AB \rightarrow B\alpha + \alpha A$.[13]

Unusual reactions involving simultaneous dissociation and precipitation have been observed in other systems, such as CuAg,[19] austenitic stainless steel,[20] and AlAg.[18] In these cases, large stacking faults grow by vacancy emission from the precipitation reaction. The precipitate nucleates on one side of the stacking fault. The strain from the volume difference is the suggested driving force for vacancy emission. An intrinsic fault can be converted to an extrinsic by absorption of a vacancy row.[13] There are two differences between S' precipitation and that in these systems. The CuAg and steel alloys are low stacking fault energy materials in which the dislocations are dissociated at the onset. There is also a large volume misfit in which the transformation strain is relieved by fault, whereas there is zero volume strain in S' precipitation.

The T_1 glide reaction on conjugate planes follows S'-Al_2MgCu precipitation (see Figure 2). The T_1 phase grows from the array of S' plates in {210} on a {111} plane. Since the inclined T_1 phases are spaced along the line, irregularities in the dislocation, such as kinks or jogs, may be the nucleation sites. A jog in a dissociated dislocation contains partial dislocations which may react or glide to form interfacial dislocations on these inclined T_1 phases. Another possibility is that an interfacial dislocation of S' expands in the formation T_1.

SUMMAFY

T_1-Al_2CuLi, S'-Al_2CuMg, and δ'Al_3Li phases nucleate on dislocations in Al-Li-Cu-Mg-Zr aged at 190°C. Dislocation orientation, character, and type of helical configuration influence the final precipitate structure.

The T_1-Al_2CuLi and S'-Al_2CuMg precipitation reactions induce the dissociation of the lattice dislocations. In the case of T_1, there is a glide reaction on (111), and in S', a climb reaction where segments dissociate into a configuration with a Shockley partial on one side.

18. NICHOLSON, R. B., and NUTTING, J. *The Metallography of Precipitation in an Al-16%Ag Alloy.* Acta. Metall., v. 9, 1961, p. 332.
19. RATY, R., and MIEKK-OJA, H. M. *Precipitation Associated With the Growth of Stacking Faults in Copper-Silver Alloys.* Phil. Mag., v. 18, 1968, p. 1105.
20. SILCOCK, J. M., and TUNSTALL, W. J. *Partial Dislocations Associated With NbC Precipitation in Austenitic Stainless Steels.* Phil. Mag., v. 10, 1964, p. 361.

DISTRIBUTION LIST

No. of Copies	To
1	Office of the Under Secretary of Defense for Research and Engineering, The Pentagon, Washington, DC 20301
	Commander, U.S. Army Laboratory Command, 2800 Powder Mill Road, Adelphi, MD 20783-1145
1	ATTN: AMSLC-IM-TL
1	AMSLC-CT
	Commander, Defense Technical Information Center, Cameron Station, Building 5, 5010 Duke Street, Alexandria, VA 22304-6145
2	ATTN: DTIC-FDAC
1	Metals and Ceramics Information Center, Battelle Columbus Laboratories, 505 King Avenue, Columbus, OH 43201
	Commander, Army Research Office, P.O. Box 12211, Research Triangle Park, NC 27709-2211
1	ATTN: Information Processing Office
	Commander, U.S. Army Materiel Command, 5001 Eisenhower Avenue, Alexandria, VA 22333
1	ATTN: AMCLD
	Commander, U.S. Army Materiel Systems Analysis Activity, Aberdeen Proving Ground, MD 21005
1	ATTN: AMXSY-MP, H. Cohen
	Commander, U.S. Army Missile Command, Redstone Scientific Information Center, Redstone Arsenal, AL 35898-5241
1	ATTN: AMSMI-RD-CS-R/Doc
1	AMSMI-RLM
	Commander, U.S. Army Armament, Munitions and Chemical Command, Dover, NJ 07801
2	ATTN: Technical Library
1	AMDAR-LCA, Mr. Harry E. Pebly, Jr., PLASTEC, Director
	Commander, U.S. Army Natick Research, Development and Engineering Center, Natick, MA 01760
1	ATTN: Technical Library
	Commander, U.S. Army Satellite Communications Agency, Fort Monmouth, NJ 07703
1	ATTN: Technical Document Center
	Commander, U.S. Army Tank-Automotive Command, Warren, MI 48397-5000
1	ATTN: AMSTA-ZSK
2	AMSTA-TSL, Technical Library
	Commander, White Sands Missile Range, NM 88002
1	ATTN: STEWS-WS-VT
	President, Airborne, Electronics and Special Warfare Board, Fort Bragg, NC 28307
1	ATTN: Library
	Director, U.S. Army Ballistic Research Laboratory, Aberdeen Proving Ground, MD 21005
1	ATTN: SLCBR-TSB-S (STINFO)
	Commander, Dugway Proving Ground, Dugway, UT 84022
1	ATTN: Technical Library, Technical Information Division
	Commander, Harry Diamond Laboratories, 2800 Powder Mill Road, Adelphi, MD 20783
1	ATTN: Technical Information Office
	Director, Benet Weapons Laboratory, LCWSL, USA AMCCOM, Watervliet, NY 12189
1	ATTN: AMSMC-LCB-TL
1	AMSMC-LCB-R
1	AMSMC-LCB-RM
1	AMSMC-LCB-RP
	Commander, U.S. Army Foreign Science and Technology Center, 220 7th Street, N.E., Charlottesville, VA 22901-5396
3	ATTN: AIFRTC, Applied Technologies Branch, Gerald Schlesinger

No. of Copies	To
	Commander, U.S. Army Aeromedical Research Unit, P.O. Box 577, Fort Rucker, AL 36360
1	ATTN: Technical Library
	Commander, U.S. Army Aviation Systems Command, Aviation Research and Technology Activity, Aviation Applied Technology Directorate, Fort Eustis VA 23604-5577
1	ATTN: SAVDL-E-MOS
	U.S. Army Aviation Training Library, Fort Rucker, AL 36360
1	ATTN: Building 5906-5907
	Commander, U.S. Army Agency for Aviation Safety, Fort Rucker, AL 36362
1	ATTN: Technical Library
	Commander, USACDC Air Defense Agency, Fort Bliss, TX 79916
1	ATTN: Technical Library
	Commander, U.S. Army Engineer School, Fort Belvoir, VA 22060
1	ATTN: Library
	Commander, U.S. Army Engineer Waterways Experiment Station, P. O. Box 631, Vicksburg, MS 39180
1	ATTN: Research Center Library
	Commandant, U.S. Army Quartermaster School, Fort Lee, VA 23801
1	ATTN: Quartermaster School Library
	Naval Research Laboratory, Washington, DC 20375
1	ATTN: Code 5830
2	Dr. G. R. Yoder - Code 6384
	Chief of Naval Research, Arlington, VA 22217
1	ATTN: Code 471
1	Edward J. Morrissey, WRDC/MLTE, Wright-Patterson Air Force, Base, OH 45433-6523
	Commander, U.S. Air Force Wright Research & Development Center, Wright-Patterson Air Force Base, OH 45433-6523
1	ATTN: WRDC/MLC
1	WRDC/MLLP, M. Forney, Jr.
1	WRDC/MLBC, Mr. Stanley Schulman
	National Aeronautics and Space Administration, Marshall Space Flight Center, Huntsville, AL 35812
1	ATTN: R. J. Schwinghammer, EH01, Dir, M&P Lab
1	Mr. W. A. Wilson, EH41, Bldg. 4612
	U.S. Department of Commerce, National Institute of Standards and Technology, Gaithersburg, MD 20899
1	ATTN: Stephen M. Hsu, Chief, Ceramics Division, Institute for Materials Science and Engineering
1	Committee on Marine Structures, Marine Board, National Research Council, 2101 Constitution Ave., N.W., Washington, DC 20418
1	Librarian, Materials Sciences Corporation, Guynedd Plaza 11, Bethlehem Pike, Spring House, PA 19477
1	The Charles Stark Draper Laboratory, 68 Albany Street, Cambridge, MA 02139
	Wyman-Gordon Company, Worcester, MA 01601
1	ATTN: Technical Library
	Lockheed-Georgia Company, 86 South Cobb Drive, Marietta, GA 30063
1	ATTN: Materials and Processes Engineering Dept. 71-11, Zone 54
	General Dynamics, Convair Aerospace Division, P.O. Box 748, Fort Worth, TX 76101
1	ATTN: Mfg. Engineering Technical Library
1	Mechanical Properties Data Center, Belfour Stulen Inc., 13917 W. Bay Shore Drive, Traverse City, MI 49684
	Director, U.S. Army Materials Technology Laboratory, Watertown, MA 02172-0001
2	ATTN: SLCMT-TML
1	Authors

U.S. Army Materials Technology Laboratory
Watertown, Massachusetts 02172-0001
PRECIPITATION ON DISLOCATIONS IN
Al-Li-Cu-Mg-Zr - D. M. Vanderwalker

AD__________
UNCLASSIFIED
UNLIMITED DISTRIBUTION

Key Words

Technical Report MTL TR 90-16, March 1990, 8 pp-illus, D/A Project: 1L161102.AH42

Aluminum alloys
Al-Li-Cu-Mg-Zr
Transmission electron microscopy (TEM)

Transmission electron microscopy was used to study precipitation processes on dislocation lines in Al-2.5Li-1.3Cu-0.7Mg-0.12Zr wt% aged at 190°C. Upon aging, a series of dislocation dissociation and precipitation reactions occur. The T_1-Al_2CuLi phase nucleates on dislocations in the (111) glide planes inducing the lattice dislocation to dissociate. On the remaining dislocation segment, S'Al_2CuMg plates form causing the lattice dislocation to dissociate into a configuration with a Shockley partial on one side and a climbing partial on the other, such that S' plates are on the (210) plane. T_1 phases nucleate from the surface of S plates on conjugate {111} with an interfacial dislocation glide motion.

U.S. Army Materials Technology Laboratory
Watertown, Massachusetts 02172-0001
PRECIPITATION ON DISLOCATIONS IN
Al-Li-Cu-Mg-Zr - D. M. Vanderwalker

AD__________
UNCLASSIFIED
UNLIMITED DISTRIBUTION

Key Words

Technical Report MTL TR 90-16, March 1990, 8 pp-illus, D/A Project: 1L161102.AH42

Aluminum alloys
Al-Li-Cu-Mg-Zr
Transmission electron microscopy (TEM)

Transmission electron microscopy was used to study precipitation processes on dislocation lines in Al-2.5Li-1.3Cu-0.7Mg-0.12Zr wt% aged at 190°C. Upon aging, a series of dislocation dissociation and precipitation reactions occur. The T_1-Al_2CuLi phase nucleates on dislocations in the (111) glide planes inducing the lattice dislocation to dissociate. On the remaining dislocation segment, S'Al_2CuMg plates form causing the lattice dislocation to dissociate into a configuration with a Shockley partial on one side and a climbing partial on the other, such that S' plates are on the (210) plane. T_1 phases nucleate from the surface of S plates on conjugate {111} with an interfacial dislocation glide motion.

U.S. Army Materials Technology Laboratory
Watertown, Massachusetts 02172-0001
PRECIPITATION ON DISLOCATIONS IN
Al-Li-Cu-Mg-Zr - D. M. Vanderwalker

AD__________
UNCLASSIFIED
UNLIMITED DISTRIBUTION

Key Words

Technical Report MTL TR 90-16, March 1990, 8 pp-illus, D/A Project: 1L161102.AH42

Aluminum alloys
Al-Li-Cu-Mg-Zr
Transmission electron microscopy (TEM)

Transmission electron microscopy was used to study precipitation processes on dislocation lines in Al-2.5Li-1.3Cu-0.7Mg-0.12Zr wt% aged at 190°C. Upon aging, a series of dislocation dissociation and precipitation reactions occur. The T_1-Al_2CuLi phase nucleates on dislocations in the (111) glide planes inducing the lattice dislocation to dissociate. On the remaining dislocation segment, S'Al_2CuMg plates form causing the lattice dislocation to dissociate into a configuration with a Shockley partial on one side and a climbing partial on the other, such that S' plates are on the (210) plane. T_1 phases nucleate from the surface of S plates on conjugate {111} with an interfacial dislocation glide motion.

U.S. Army Materials Technology Laboratory
Watertown, Massachusetts 02172-0001
PRECIPITATION ON DISLOCATIONS IN
Al-Li-Cu-Mg-Zr - D. M. Vanderwalker

AD__________
UNCLASSIFIED
UNLIMITED DISTRIBUTION

Key Words

Technical Report MTL TR 90-16, March 1990, 8 pp-illus, D/A Project: 1L161102.AH42

Aluminum alloys
Al-Li-Cu-Mg-Zr
Transmission electron microscopy (TEM)

Transmission electron microscopy was used to study precipitation processes on dislocation lines in Al-2.5Li-1.3Cu-0.7Mg-0.12Zr wt% aged at 190°C. Upon aging, a series of dislocation dissociation and precipitation reactions occur. The T_1-Al_2CuLi phase nucleates on dislocations in the (111) glide planes inducing the lattice dislocation to dissociate. On the remaining dislocation segment, S'Al_2CuMg plates form causing the lattice dislocation tc dissociate into a configuration with a Shockley partial on one side and a climbing partia' on the other, such that S' plates are on the (210) plane. T_1 phases nucleate from the surface of S plates on conjugate {111} with an interfacial dislocation glide motion.